Chapter 4

Airspace Development

Airspace design requires extensive coordination between air traffic controllers and airspace planners, and several efforts are underway to improve the efficiency of the airspace system. Airspace Capacity Studies, for example, have been completed or are underway at 20 major areas in the United States.

These Airspace Capacity Studies are a joint effort among the Office of System Capacity and Requirements, Air Traffic, Regional Headquarters, and a contractor that conducts the simulation modeling. Air Traffic, normally at the Regional level, develops the alternatives that will be tested in the simulation runs. These studies sometimes reflect community involvement and FAA's responsiveness to community-developed alternatives. Most of the studies take a "systematic" approach, examining the proposed alternatives in an ARTCC-wide context.

A variety of computer models have been used to analyze a broad spectrum of capacity solutions. Since 1986, the Office of System Capacity and Requirements has been applying SIMMOD, the FAA's Airport and Airspace Simulation Model, to large scale airspace redesign issues. The first such project was an analysis of the Boston ARTCC in support of the expansion of that facility's airspace. Similar studies were initiated at the Los Angeles, Fort Worth, and Chicago ARTCCs, studying issues as diverse as resectorization, special use airspace restrictions, new routings, complete airspace redesign, and new runway construction. Computer modeling has been used to quantify delay, travel time, capacity, sector loading, and aircraft operating cost impacts of the proposed solutions.

The most productive solutions to capacity and delay problems have generally involved additional runways, but efficiencies have also been identified in airspace design. At Dallas-Ft. Worth, for example, effects of the Metroplex plan (see Section 4.4) were studied both with and without new runway construction. Results indicated an immediate savings from airspace changes alone.

Table 4-1 summarizes the airspace studies discussed in this chapter by listing the generalized categories of the various alternatives studied. The majority of the studies considered new arrival and departure routes, modifications to ARTCC traffic, and redefinition of TRACON boundaries among their alternatives. Two studies, at Denver and Houston-Austin, analyzed a new airport with its associated airspace, while three studies, at Kansas City, Dallas-Ft. Worth, and Chicago, analyzed new runways at existing airports.

Airspace Capacity Studies, a joint effort among the Office of System Capacity and Requirements, Air Traffic, Regional Headquarters, have been completed or are underway at 20 major areas in the United States.

Airspace Studies serve to illustrate the "system" nature of the delay problem and to emphasize the need for an integrated approach that develops capacity improvements throughout the aviation system.

Four of the studies, Houston-Austin, Oakland, Dallas-Ft. Worth, and Los Angeles, modeled military traffic, restricted airspace, special use airspace, or the interactions of a military airfield with the civilian airport. This summary serves to illustrate the "system" nature of the delay problem and to emphasize the need for an integrated approach that develops capacity improvements throughout the aviation system.

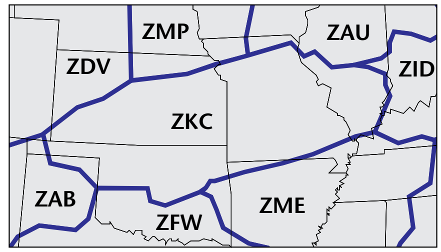
The FAA plans to institutionalize these airspace modeling activities by expanding the capability of its Technical Center in Atlantic City, N.J. Under the guidance of a policy level work group in Washington, the Technical Center, and soon the National Simulation Capability, will provide the FAA with the resources to conduct studies using a variety of models.

What follows are excerpts from the airspace studies completed to date. It should be noted that these studies only considered the technical and operational feasibility of the proposed alternatives. Environmental, socioeconomic, and political issues will be addressed in future planning studies.

Table 4-1. Summary of Airspace Improvement Alternatives Analyzed.

Studied Alternatives / Airspace Regions	Chicago	Dallas-Ft. Worth	Denver	Expanded East Coast Plan	Houston-Austin	Kansas City	Los Angeles	Oakland
Relocating arrival fixes	√	√				√		
New arrival routes		√	√	√	√	√		√
New departure routes	√		√	√	√	√	√	√
Modifications to ARTCC traffic		√		√	√	√	√	√
New airport			√		√			
Hub/non-hub alternatives					√			
Change in metering restrictions	√			√				√
Redifining TRACON boundaries		√		√	√		√	√
Military traffic considered		√			√		√	√
New runways at existing airports	√	√				√		
Specific modeling of 2 or more airports for interactions analysis	√	√				√		

4.1 Kansas City Area Airspace Project[1,2,3]



The purpose of the Kansas City Airspace Capacity Project was to evaluate proposed operational alternatives in the St. Louis and Kansas City TRACONs and Kansas City ARTCC airspaces. The Kansas City Airspace Capacity Project consisted of three simulation analyses. Results of each were analyzed with respect to increasing capacity, reducing delay, and improving efficiency.

4.1.1 St. Louis TRACON Operational Alternatives

The first simulation analysis considered delay and capacity impacts at Lambert-St. Louis International Airport (STL) associated with relocating arrival fixes based on a four cornerpost VOR concept, implementing dual arrival routes over the cornerposts, and developing new departure routes.

Two options for the St. Louis TRACON were studied. The first alternative considered a dual arrival route system with no other modifications to the existing TRACON or Kansas City ARTCC airspace and traffic systems.

The second alternative considered a four cornerpost VOR system, relocating arrival fixes, providing dual arrival routes, adding new departure gates for St. Louis TRACON, and making significant Kansas City ARTCC routing changes. Greater delay savings were realized from the second alternative than from the first as a result of the proposed airspace changes. These proposed changes reduce restrictions on aircraft flowing through the arrival fixes and increase the number of departure routes available, thus making use of previously unused runway capacity at STL due to increased airspace capacity in the St. Louis TRACON.

A recommendation of the study was that runway capacity expansion at STL should be considered if the potential benefits of a new airspace network are to be realized during IFR conditions.

The Lambert-St. Louis International Airport Capacity Enhancement Plan, completed in 1988, addressed this issue. The goals of the study were to increase IFR capacity at the airport to equal VFR capacity. The recommendations of the St. Louis Task Force Study are listed in Appendix C.

1. Kansas City Airspace Capacity Project (May 1991)
2. Lambert-St. Louis International Airport Capacity Enhancement Plan (June 1988)
3. Kansas City International Airport Capacity Plan (September 1990)

Recommendations for St. Louis designed for airfield improvement included: constructing a new runway parallel to Runway 12L/30R, constructing angled exits on Runway 12L/30R, and constructing three major taxiway extensions parallel to Runway pairs 12R/30L and 12L/30R and Runway 6/24.

Facility and equipment improvements recommended included: installing a CAT III ILS system on Runways 12L and 30R, installing a precision approach system on Runway 6 to lower landing minimums on Runway 6 and also to support approaches during IFR weather conditions to Runways 30R and 30L, and installing runway alignment indicator lights (RAILs) and centerline lights on Run-way 24 to lower approach minimums and support converging approaches during IFR to Runways 24, 30L, and 30R.

4.1.2 Kansas City TRACON Operational Alternatives

The second simulation analysis evaluated proposed airport/airspace improvements designed to increase capacity at Kansas City International Airport (MCI). This analysis considered three alternatives. The first alternative added a new north/south parallel runway at MCI. The second alternative analyzed a four cornerpost VOR system, relocated arrival fixes, and provided dual arrival routes for MCI. The third alternative included the four cornerpost VOR system, relocated the arrival fixes, added dual arrival routes, and added a new north/south parallel runway at MCI.

Simulation results of the second alternative showed that there would be daily savings in delay gained by using the proposed four cornerpost VOR system. The delay savings, though, are only realized during VFR weather conditions.

The third alternative resulted in added delay savings for both VFR and IFR weather conditions. The capacity increases afforded by dual runways and dual arrival routes significantly increased airfield capacity, especially at the 200 percent traffic demand level.

Runway capacity expansion at Kansas City International Airport is to be strongly considered and was a major objective of the Kansas City Capacity Design Team in its report of September 1990. Recommendations that directly relate to increasing runway capacity under IFR weather conditions are listed in Appendix C.

Recommendations for Kansas City designed for airfield improvement included: independent 9,500 foot parallel Runway 1R/19L, independent 10,000 foot parallel Runway 18R/36L, high speed exits for Runways 1L and 19R, and high speed exits for Runway 27R.

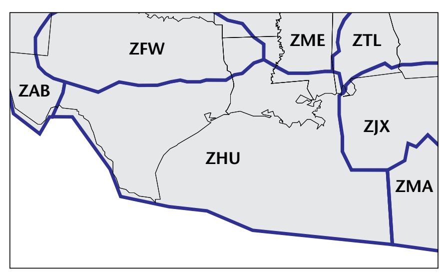
Facility and equipment improvements recommended included: installing a CAT III ILS for Runway 1R, installing a CAT I ILS for Runway 19L to allow for simultaneous approaches to Runways 19L and 19R, installing an ILS/MLS for Runway 27R to provide precision approaches and allow for simultaneous converging approaches to Runway 27R and north/south runways in IFR without the application of visual separation, and upgrading Runway 1L ILS to CAT III.

4.1.3 Kansas City En Route Airspace Alternatives

The third simulation analyzed modifications of Kansas City ARTCC traffic flows to align with the St. Louis and Kansas City TRACON arrival and departure changes made in the first two simulations, rerouted overflight traffic based on specific destination criteria, and raised the ceiling on low altitude sectors from FL230 to FL270.

Simulation results show that raising the low altitude ceilings to FL270 would provide immediate delay savings at the baseline demand level and as overflight traffic increases within Kansas City ARTCC. Higher ceilings for low altitude sectors should provide a more balanced distribution of traffic by sector.

4.2 Houston/Austin Airspace Project[4]



The purpose of the Houston/Austin Airspace Capacity Project was to support the FAA Southwest Region in their planning efforts and quantitatively evaluate the impacts of proposed operational alternatives in the Houston and Fort Worth Air Route Traffic Control Centers (ARTCCs), terminal airspace operations in the Austin Terminal Radar Approach Control (TRACON), and airfield operations at the existing Robert Mueller Airport and at the proposed new Manor Airport in Austin.

The Austin TRACON provides air traffic control services in the terminal airspace surrounding Robert Mueller Airport. Austin TRACON airspace has Robert Mueller Airport located near the center and Bergstrom Air Force Base located southeast of Robert Mueller Airport. In addition to Robert Mueller Airport, the primary airport, there are 11 satellite airports within the Austin TRACON.

4. Houston/Austin Airspace Capacity Project (May 1991)

Two simulation analyses were conducted to quantitatively evaluate the capacity and delay impacts of operational alternatives in the Houston and Fort Worth Centers and in the Austin TRACON. The first involved evaluating the capacity gains and delay reductions that would result from construction of the new airport at Manor, Texas, including redesigning airspace structures, routings, and procedures in the Austin TRACON. The second simulation analysis involved analyzing the impacts of potential rerouting of specific Austin-bound traffic from the east coast through the Fort Worth Center instead of via the present routing through the Houston Center.

4.2.1 New Austin Airport/Airspace System

The runway system for the existing Austin Municipal Airport, Robert Mueller Airport, consists of three runways: two parallel diagonal runways and a north/south runway. The existing airspace system uses a combination of radar vectors and preferential arrival routes for arriving aircraft bound for airports within the Austin terminal area. In addition, an approach is available for Bergstrom AFB high performance jet arrivals. Aircraft depart the Austin TRACON airspace via radar vectors, preferential departure routes, or the jet airway structure.

The proposed system incorporates several major airspace and procedural modifications. The new airport will be located near the town of Manor, which is approximately 11 miles northeast of Mueller Airport, around which the existing airspace and procedures were designed. The new proposed Manor Airport consists of two parallel air carrier runways, spaced 5,800 feet apart. The spacing between the two runways allows simultaneous independent IFR approaches. In order to accommodate the new airport's traffic patterns and extended final approach courses, Austin TRACON airspace will be expanded 5 miles northward and eastward to a point approximately 35 miles east of the Manor Airport.

A modified four cornerpost system is proposed for arrivals, providing for segregated traffic, both vertically and laterally separated on parallel arrival routes from three directions. The departure route design is based on major traffic flows allowing for segregation by destination. The plan allows for multiple departure routes diverging at or near the airport resulting in an increased departure capacity. With about 70 percent of Bergstrom Air Force Base traffic operating to the west, a separate departure route dedicated to military operations was created, thereby segregating very high performance aircraft from other types.

Traffic demand schedules were generated for two scenarios. The first projected traffic growth without the development of an airline hub at the new Manor Airport, and the second scenario projected traffic growth with the development of an airline hub. Each scenario assumed little or no change in general aviation and military operations, moderate growth in commuter operations, and significant growth in air carrier operations.

Weather conditions strongly influence the capacity at Mueller Airport due to impacts on runway utilization and dependencies, procedures, and separation criteria. Under IFR, capacity decreases at both the existing and proposed airports primarily because arriving aircraft must conduct instrument approaches, thus increasing separation requirements for arriving aircraft and between successive departure operations. At the existing airport, decreases result due to the inability to run simultaneous approaches to the closely-spaced parallel runways and to the dependency of departure operations from the two runways. In addition, converging approaches at the existing airport are impractical. At the new proposed Manor Airport, on the other hand, the runways are spaced far enough apart that there is no dependency between departure operations, and criteria for simultaneous ILS approaches are met, resulting in a higher capacity operation than that at the existing airport.

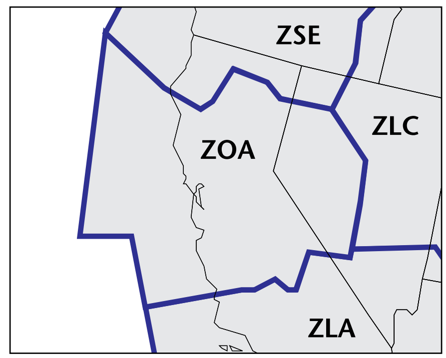
Simulation results indicate that airspace restructuring and the construction of a new airport at Austin with two new independent air carrier runways would result in significant increased capacity and cost savings when compared to the existing airfield and airspace structure. Delay and cost savings would be realized for both the hub and non-hub projections in traffic growth.

4.2.2 East Coast Traffic Rerouting Option

The second simulation analysis evaluated proposed rerouting of specific Austin-bound East Coast traffic. East Coast jet traffic arriving at Austin from the direction of Atlanta, Georgia, is currently routed entirely through Houston Center. An alternative route under consideration involves routing the traffic through Fort Worth Center at high altitude with the jet traffic bound for the DFW area. The flights bound for Austin would descend southwest bound to enter Houston Center south of the Waco VORTAC, in-trail with other Austin arrivals from the DFW area. Air traffic operations in the Houston and Fort Worth Centers for three demand levels under VFR were simulated. The new Austin airport/airspace system was assumed to be in place, with an airline hub serving the East Coast established at Manor Airport, by the second traffic demand level.

Simulation results for the hub scenario traffic demand levels provided results for assessing the delay impact of the routing alternatives. The overall system-wide delay associated with routing the east coast traffic through Houston Center was compared with the corresponding delay associated with routing the traffic through Fort Worth Center. Simulation results indicate that flights incur less travel time when routed via the present route through Houston Center instead of the alternative route through Fort Worth Center.

4.3 Oakland Airspace Project[5,6]



The purpose of the Oakland Center Airspace Analysis Project was to evaluate the delay and capacity impacts of proposed operational alternatives aimed at increasing capacity, reducing delay, and improving the overall efficiency of air traffic operations within the Oakland Air Route Traffic Control Center (ARTCC), terminal airspace operations in the Bay and Sacramento Terminal Radar Approach Controls (TRACONs), and airfield operations at San Francisco International (SFO), Metropolitan Oakland International (OAK), San Jose International (SJC), and Sacramento Metropolitan (SMF) Airports.

The Oakland Air Route Traffic Control Center (ARTCC) adjoins three other domestic ARTCCs and has an oceanic control area to the west, which provides air traffic services to transpacific flights. Air traffic operations within Oakland Center airspace are very complex. There exists a significant east to west and north to south traffic flow, several interactive, high density airports, considerable military activity, and numerous geographical constraints restricting radar coverage, radio communications, and air traffic movement. Traffic handled by the Oakland Center includes overflights, arrivals, departures, and intra-center traffic. Due to its geographical location, the majority of flights within the Oakland ARTCC are either climbing or descending. The three Bay Area airports account for over 55 percent of the total Oakland Center IFR operations.

The Oakland Center Airspace Analysis Project consisted of four major simulation analysis tasks. Results of each were analyzed with respect to increasing capacity, reducing delay, and improving the overall efficiency of air traffic operations and are summarized below.

5. Oakland Center Airspace Analysis Project (June 1991)
6. San Francisco Bay Area Airports Task Force Capacity Study of SFO, SJC, and OAK International Airports (December 1987)

4.3.1 Sector 11 Initiative

The first simulation analysis task involved evaluating two proposed airspace realignment and routing alternatives to alleviate complexity and saturation problems associated with Oakland Center Sector 11.

Sector 11 is one of 25 en route sectors located within the Oakland Center. The base of Sector 11 airspace commences at the surface and attains its highest altitude at FL230. Some shelving exists at the lower altitudes, mainly where Sector 11 interfaces with Bay TRACON, Monterey Approach Control, and Stockton Approach Control. Sector 11 is a relatively small sector, encompassing the majority of the area south of San Jose International Airport, approximately 45 miles north to south and 60 miles east to west.

Alternative A involved an extension of the lateral and vertical confines of Bay TRACON, Monterey Approach Control, and Stockton Approach Control; a modification to the major San Jose International Airport jet arrival routes to conform with proposed boundary and procedure changes between Bay TRACON and Oakland ARTCC Sector 11; and a reduction in metering restrictions to San Jose International Airport from the Los Angeles Basin and southwestern U.S. Alternative B included the changes proposed in Alternative A, plus it extended the ceilings of Monterey and Stockton Approach Controls.

Both improvement options proposed under the Oakland Sector 11 Initiative result in capacity gains and delay savings, though Alternative B results in greater delay savings when compared to baseline operations. This is due to fewer aircraft impacting Oakland Center Sector 11 and reduced in-trail separation standards required within approach control airspace. Besides the operating cost savings realized under the Sector 11 improvement alternatives, additional benefits would include: reduced Sector 11 complexity and traffic density; increased sequencing flexibility for Bay TRACON to merge traffic; reduced en route traffic metering; reduced inter-facility and intra-facility coordination; and a more efficient airspace alignment, resulting in an increased capacity to handle future traffic demand with reduced delay.

There is a narrowing of the margin between the delay and cost savings benefits between the alternatives in future demand levels when compared to the baseline and to each other due to limited runway capacity at San Jose International Airport. Future runway capacity expansion at San Jose International Airport should be a serious consideration if the potential benefits of any new airspace network are to be fully realized for increased traffic demands and IFR conditions.

The San Francisco Bay Area Airports Capacity Task Force's major objective, in its report of December 1987, was to develop an action plan to increase capacity and efficiency and to reduce aircraft delays at the three Bay Area international airports. Recommendations for San Jose designed to maximize the benefits of redesigned airspace include: creating staging areas at Runways 30L and 30R, extending and upgrading Runways 30R and 29, creating angled exits for Runway 12R, promoting use of reliever ILS training facilities, installing MLS on Runway 30L, and implementing simultaneous departures with Moffett Field.

4.3.2 Northern California Combined Radar Facility (NORCAL CRF) Airspace Redesign

The second task in this analysis involved analyzing the system capacity and air traffic delay impacts associated with combining several approach control facilities and delegating airspace from Oakland ARTCC to form the proposed Northern California Combined Radar Facility (NORCAL CRF). The proposed operational changes required: combining Bay TRACON, Travis RAPCON, Sacramento Approach Control, Stockton Approach Control, and portions of Oakland ARTCC into a single radar approach control facility; expanding Monterey Approach Control's area of jurisdiction; developing new sectors and modifying existing sectors within all facilities to conform with the proposed airspace changes; extending Runway 30R at San Jose International Airport to 7,460 feet for specific improvement options; and modifying arrival and departure routes to coincide with the proposed airspace changes. Results were analyzed for VFR and IFR conditions.

Simulation results show that the consolidation of facilities to establish the NORCAL CRF would result in capacity gains, delay savings, and aircraft operating cost savings. Potential benefits associated with establishing the NORCAL CRF facility include: increased sequencing flexibility to merge traffic using terminal in-trail separation criteria; expansion of available TRACON airspace for vectoring of arrival and departure traffic; improved efficiency in merging traffic with Oakland Center; reduced inter- and intra-facility coordination, and a more efficient airspace alignment resulting in increased capacity to handle future traffic demands with reduced delay. The extension of Runway 30R at San Jose International Airport would provide increased capacity to more efficiently accommodate current traffic demand as well as future traffic growth at the airport. Extending Runway 30R at San Jose International

Airport in conjunction with implementing the NORCAL CRF airspace redesign produces even greater delay savings and cost benefits than separately adding together the delay benefits and cost savings of each option.

4.3.3 Sacramento Airspace Routings Analysis

The third simulation analysis task involved evaluating alternative routings and procedures proposed to alleviate noise problems in the Sacramento Metropolitan area. Analyses were performed to determine the impact that these routings might have on current traffic flows within the Sacramento TRACON and Oakland Center. Four routing options were analyzed (one northwind and three southwind operations); a combination of the northwind alternative with each of the southwind alternatives was also analyzed.

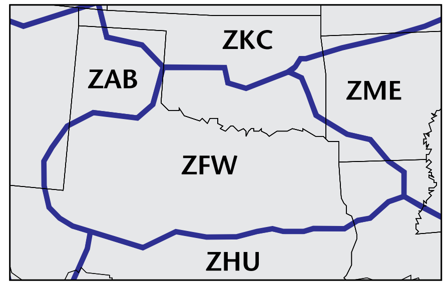
Simulation results show that the four alternative options do not yield any significant arrival delay changes for the baseline traffic demand at Sacramento Metropolitan Airport.

4.3.4 Fallon Special Use Airspace Impact Analysis

The fourth simulation analyzed the capacity and delay impacts associated with rerouting specific traffic to evaluate a proposed reconfiguration of the Fallon Range Training Complex. The proposed operational changes included raising the ceiling on the Fallon area and rerouting civilian traffic currently overflying the Fallon military airspace onto existing routes that circumvent the Fallon training area.

The expansion of the Fallon Range Training Complex significantly reduces Sector 43's airspace previously available for the vectoring of traffic to relieve congestion. The proposed expansion of the Fallon Range Training Complex is situated on a major west to east air traffic corridor. Requiring traffic to be rerouted around or clear of the proposed Fallon Range Training Complex restricts the majority of the departure traffic to using two primary departure routes. This rerouting of traffic results in increased ground delay at impacted airports due to the necessity to provide in-trail separation on airway specific routes instead of utilizing vectors and/or direct routes to expedite traffic movement.

4.4 Dallas-Fort Worth Metroplex Project[7]



The objective of the Dallas-Ft. Worth (DFW) Metroplex Air Traffic Analysis Project was to address a variety of capacity and delay problems and issues in the Dallas/Ft. Worth area, including development of plans for increasing airport and airspace capacity.

This project focused on three primary areas: (1) evaluation of the new airspace design for the DFW area, (2) assessment of the need for and alternatives for providing and utilizing new runway capacity at DFW Airport, and (3) evaluation of the capacity and delay impacts of airspace interactions among traffic from various airports in the DFW area.

These analyses relating to the new DFW airspace were aimed at evaluating and refining routings and procedures for the new airspace design, analyzing the capacity of the new airspace design to accommodate future traffic volumes and expanded airport capacity, and assessing the capability of the new airspace to support procedures for four simultaneous ILS approaches to DFW Airport. Analyses relating to the new runway capacity at DFW Airport were aimed at analyzing new runway alternatives in terms of the type of runway (commuter or air carrier), timing of construction, location on the airfield, use configurations, and operating procedures. Airspace interaction problems analyzed included the interaction between departures from Dallas Love Field and DFW Airport under both North Flow and South Flow operations, and the interactions between DFW Airport arrivals and Navy Dallas Airfield departures and arrivals during North Flow operations.

4.4.1 New Airspace Design for the DFW Area

Simulation analyses were conducted to analyze the capacity of the new DFW airspace system being designed by the DFW Metroplex Program Office of the FAA's Southwest Region. Major modifications to the old system include: expand TRACON airspace from 30 nm to 40 nm by relocating cornerposts and adding two new VORTACs, establish dual jet routing for arrivals over each cornerpost, establish additional terminal departure routings, segregate jet, turboprop, and prop traffic, segregate some military flights from civilian traffic, revise nominal radar vector paths within the TRACON, and revise arrival and departure routings in the Fort Worth Center.

7. The Dallas/Ft. Worth Metroplex Air Traffic Analysis Project (November 1989)

Simulation results show that the maximum benefits from the new airspace design will be realized in the future, with expected airport capacity improvements and increased demand levels, but the airspace design will also yield significant delay reductions and cost savings under current demand levels with existing airport facilities. Furthermore, the simulation results verify that the new airspace system provides the capacity to efficiently accommodate the increased traffic levels forecast through year 2010, including traffic associated with two new air carrier runways at DFW Airport. The new airspace structures and procedures provide the throughput to feed four simultaneous ILS approaches to DFW Airport.

4.4.2 New Runway Capacity at DFW Airport

The simulation of increased levels of traffic clearly indicate that existing runway facilities at DFW Airport do not provide adequate capacity to accommodate forecast traffic demand in the upcoming decade. Without new runway capacity, delays will increase to levels that result in severe economic penalties to aircraft operators and will be too expensive to support planned operations.

Potential airfield improvements at DFW Airport included north extensions on each of the north/south runways on either side of the terminal area with departure staging areas, a new eastside runway with associated taxiways, a new westside runway with associated new taxiways, new terminal facilities, and relocation of the general aviation parking area. The changes that were assumed to be in place depended on the demand year and runway options under consideration in the various simulation runs.

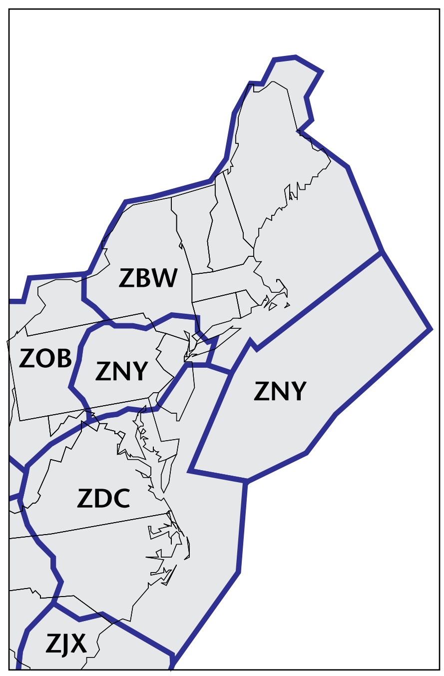
The results from the simulation runs indicated that to maintain the baseline (1987) level of service at DFW Airport (i.e., without increasing flight delays), a new commuter runway will be needed in 1990, a new air carrier runway in the mid 1990's, a new commuter runway and a new air carrier runway around 2000, and two new air carrier runways around the year 2005. In addition, the operational benefits that can be realized by a new north/south air carrier runway on the westside of DFW Airport depends on its location relative to the existing westside diagonal runway. The two options for locating a new westside air carrier runway were an intersecting option and a non-intersecting option. It was assumed that triple independent IFR approaches can be conducted when one new runway is available and quadruple approaches can be conducted when two new runways are available. Increased cost savings will be realized if the new westside runway is non-intersecting. In addition, the complexity of operations and controller workload would be less for the non-intersecting alternative. These savings must be weighed against the greater construction costs for a new non-intersecting runway.

4.4.3 Airspace Interactions between DFW Airport and Satellite Airport Traffic

Simulation analyses were conducted to evaluate the capacity and delay impacts of airspace interactions among traffic from various airports in the DFW area. Airspace interaction problems analyzed included the interaction between departures from Dallas Love Field and DFW Airport under both North Flow and South Flow operations, and the interaction between DFW Airport arrivals and Dallas Naval Air Station (NAS) departures and arrivals during North Flow operations.

Simulation results indicate that potential interactions between departures from DFW Airport and Dallas Love Field during South Flow operations are particularly critical. Substantial delay savings result from using routings and procedures that minimize airspace interactions between DFW Airport and Dallas Love Field departures and should be strongly encouraged.

4.5 Expanded East Coast Plan[8]



The purpose of the Airport and Airspace Simulation Model (SIMMOD) application to the Expanded East Coast Plan (EECP) was to support the FAA in its planning efforts to restructure airspace operations on the East Coast of the United States to increase capacity, reduce delays, and improve overall efficiency of the air traffic system.

The application effort was concerned with New England's portion of the EECP, which focused on airspace operations in the Boston Air Route Traffic Control Center (ARTCC). Simulation efforts focused on redesigning traffic routings, ATC procedures, and airspace sectors that would properly interface with other portions of the EECP (i.e., the New York area), and that would yield increased capacity and reduced delays in the Boston ARTCC airspace.

Boston Center airspace operations are complex, involving significant East/West and North/South flows. Of the more than 100 airports underlying the Boston Center airspace, Logan International Airport flights account for almost 25 percent of Boston Center total traffic. Traffic handled by the Boston Center includes overflights, arrivals, departures, and intra-center traffic. Because of

8. Airport and Airspace Simulation Model (SIMMOD) Application to the Expanded East Coast Plan (October 1987)

the geographic location, most flights in the Boston Center are climbing or descending, including intra-center flights, oceanic traffic, and traffic accepted from and handed to adjacent facilities. The climbs, descents, routings, and other airspace maneuvering required by these flights contribute to the complexity of air traffic operations. Adjacent to Boston Center to the southwest is New York Center. Just within the New York Center airspace is a major "hub area," including Kennedy, LaGuardia, and Newark Airports. Many flights departing from or arriving at these airports must transit through Boston Center airspace. Montreal Centre is adjacent to Boston Center to the north. Due to the close proximity of Montreal area airports to the center boundary, much of the traffic to and from Montreal is climbing or descending.

Simulation runs were conducted for both the current Boston ARTCC operations (routes, sectors, and procedures) as well as new proposed EECP operations for a baseline traffic demand schedule.

4.5.1 Current Operations

Operational procedures used under the current system to control aircraft in Boston Center airspace rely primarily on maintaining minimum en route separation requirements. Certain flights, however, have added restrictions placed upon them in the form of specific routing, altitude, and miles-in-trail separation requirements.

For the current system simulation, the standard restrictions that are routinely in effect on a daily basis were assumed. They include miles-in-trail restrictions on aircraft entering Sardi, Stewart, and Pawling sectors for certain periods of the day, and miles-in-trail restrictions on specific Boston Center flights being handed to New York Center and Cleveland Center.

A traffic demand schedule was developed for a baseline day of operations in Boston Center airspace in 1987 which included air carrier, military, air taxi, and general aviation departures, arrivals, and overflights.

4.5.2 Proposed Operations

Major modifications to the current system include:

(1) Boston Center airways were restructured to provide direct routings for established traffic flows with less radar vectoring,

(2) Boston Center departure routes were realigned with revised New York Center EECP routings,

(3) More efficient routings for arrivals into the Boston Center were provided,

(4) Boston Center airspace sectors were revised to efficiently accommodate traffic flows and uniformly distribute the traffic load among sectors,

(5) Airspace sectors were made less complex by reducing the amount of "shelving," i.e., variation of sector shape with altitude, and

(6) TRACONs were delegated more airspace to enhance the efficient use of Tower En Route Control (TEC) routings.

In addition, procedures for metering arrivals into Logan Airport were identified for potential implementation in the proposed EECP system.

Several simulation cases were run. The first analysis was one where no runway constraints were present. It was assumed that the airports can accept arrivals at the rate the airspace can deliver the aircraft to the runway, subject to all airspace route, procedure, and separation constraints. Another case involved having representative airport arrival acceptance rate (AAR) constraints imposed. Two AARs for Logan Airport were selected for the analysis. The first was an AAR of 60 which allowed 34 arrivals per hour on the primary runway and 26 on the secondary runway. The second was an AAR of 36 which allowed 26 arrivals per hour on the primary runway and 10 arrivals on the secondary runway.

It was also decided to evaluate the impacts of arrival sequencing and spacing procedures on delay. In the current system, the primary method for spacing arrivals is to set independent miles-in-trail constraints on the various arrival flows which feed the runways at Logan Airport, so as to stay within the AAR constraints. The use of coordinated arrival metering procedures is being considered for use in the proposed EECP system. Thus, the simulation cases included the AAR 60 and AAR 36 cases, with and without arrival metering.

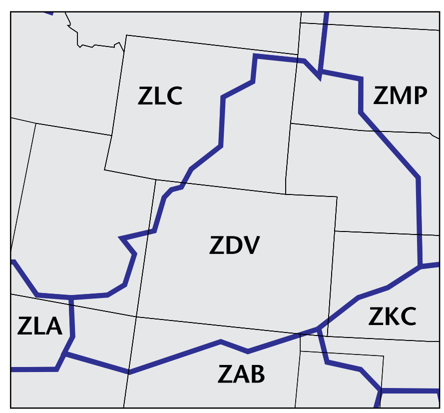
Simulation results indicate that from a purely airspace point of view, the new proposed EECP airspace routings and sectorizations will result in substantial efficiency and capacity gains. Flight time savings increase as the AAR level is decreased. Additional delay reductions are realized when coordinated arrival metering procedures are used.

An analysis was conducted to evaluate the capacity of the proposed EECP system to handle increased levels of traffic demand, compared to that of the current system.

Simulation results show that the amount of delay at all traffic levels is significantly less for the proposed system than for the current system. It was also found that the proposed system is able to absorb approximately ten percent more traffic before it reaches the same overall delay level experienced in the current system.

Based on an analysis of the sector occupancy statistics, it can be concluded that the proposed EECP system will reduce the intensity of traffic in airspace sectors. The reduced traffic congestion has the potential to alleviate sector saturation, reduce controller workload, and enhance aviation safety.

4.6 New Denver Airport/Airspace Study[9]



The purpose of the New Denver Airport/Airspace Study was to help the FAA's Northwest Mountain Region in their plans to realign en route and Terminal Radar Control (TRACON) airspace so that air traffic operations can be efficiently accommodated at the new Denver Airport. The New Denver Airport/Airspace Study consisted of two airspace options and two runway use plans. Each alternative was analyzed with respect to increasing capacity, reducing delay, and improving efficiency.

Stapleton International Airport is nearing capacity and will not be able to accommodate traffic forecasts of 1,900 operations per day in 1993. The city of Denver, Colorado is planning to replace Stapleton International Airport with a new airport in order to accommodate the forecast increases in traffic. The new Denver airport will be located approximately 10 miles northeast of Stapleton International Airport and is scheduled to open in 1993 with five runways. Existing plans for the new airport include expansion to twelve runways as the traffic demand increases to 3,600 operations per day.

9. New Denver Airport/Airspace Study (October 1989)

The six runway configuration consists of four north/south runways (two on either side of the terminal area) and two east/west runways. One is located north of the two runways on the right side of the terminal area and the other is located south of the runways on the left side of the terminal area. All runways are 12,000 feet long with the exception of one runway that is 16,000 feet long. The runway spacing is large enough for three simultaneous ILS approaches during IFR conditions. The airport is primarily a north/south flow airport; the two east/west runways are used as offload runways during north or south flow operations.

The new Denver Terminal Radar Approach Control (TRACON) will be operated as an arrival/departure gate system. Two arrival/departure gate options and two runway utilization plans were analyzed.

4.6.1 Terminal Airspace Design Evaluation

The TRACON airspace for the New Denver Airport is bound by a circle, centered at the New Denver Airport, with a radius of 30 nautical miles, and extends from the ground to 20,000 feet in altitude. The basic design involves four arrival and four departure gates to accommodate traffic associated with the New Denver Airport and satellite airports (Jeffco, Centennial, and Front Range). Two options for placement of the arrival/departure gates were analyzed. Option 1 involves roughly symmetric distribution of arrival and departure gates around the boundary of the TRACON. The arrival gates are placed so that existing airways that feed the arrival gates at Stapleton International Airport can be used. In Option 2, the arrival gates are moved so that the north and south departure gates are smaller.

Simulation results show that Option 1 provides more capacity and more efficient operations than Option 2. Delay reductions and more efficient airspace routings result in substantial savings in aircraft operating time for Option 1.

4.6.2 Runway Use Analysis

The New Denver Airport is scheduled to open in 1993 with a five-runway configuration. Two runway use plans were evaluated. The plans differ in terms of criteria for offloading aircraft from the primary runways during arrival and departure peaks. Plan 1 assumes the use of procedures similar to those currently used at Stapleton International Airport. Plan 2 involves more demand-responsive use of runways, with the number of arrival and departure runways varying with demand, and with balanced utilization of available runway capacity.

The runway utilization for departure rushes under Plan 1 is the same for VFR and IFR operations, where up to four runways are available to handle the departure rush. During a VFR arrival rush, up to five arrival runways are available, depending on the size of the arrival rush. The runway use is balanced so that arrivals are evenly allocated to the arrival runways, and departures are evenly allocated to departure runways. The main difference between VFR and IFR operations is the number of arrival runways. Only three arrival runways are available for IFR operations because the east/west runways become departure runways.

Under Plan 2, the departure rush runway utilization is the same for VFR and IFR operations as it is for Plan 1. During a VFR arrival rush, four runways are always available for arrivals. The arrival and departure use is not balanced. As in Plan 1, only three IFR arrival runways are used.

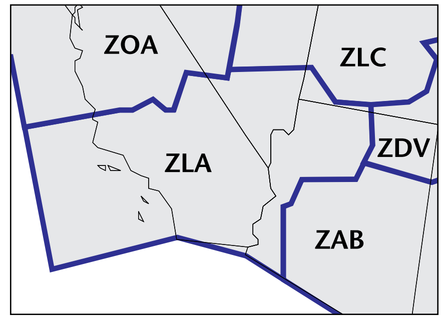
Simulation results show that substantial benefits may be realized using Plan 2 instead of Plan 1.

4.6.3 New Denver Airport and Terminal Airspace Capacity Analysis

The traffic demand at the New Denver Airport is forecast to be 1,900 daily operations when it opens in 1993. This was used as the baseline demand. An analysis was conducted to evaluate the capacity of the New Denver Airport and terminal airspace using airspace Option 1 and runway use Plan 2. The analysis was conducted for VFR and IFR operations with baseline and increased demand in increments of 10 percent, up to a 50 percent increase over the baseline demand.

Simulation results show that there is sufficient airspace and runway capacity to accommodate future growth with six runways when the runways are used efficiently. The use of airspace Option 1 and runway use Plan 2 will provide adequate capacity to accommodate expected future traffic growth of up to 30 percent over baseline demand with modest increases in annual delay. For demand increases greater than 30 percent over baseline, additional runway capacity at the New Denver Airport will be required to avoid substantial increases in delay.

4.7 Los Angeles Airspace Project[10,11]



The purpose of the Los Angeles Airspace Capacity Project was to support the FAA Western-Pacific Region in their planning efforts and analyze several critical capacity and delay problems and issues in the Southern California area.

Los Angeles Center airspace operations are complex, involving significant East/West and North/South flows. Traffic handled by the Los Angeles Center includes overflights, arrivals, departures, and intra-center traffic. Because of its geographic location, most flights in the Los Angeles Center are climbing or descending. Los Angeles International Airport flights account for almost 30 percent of Los Angeles Center total traffic.

Immediately adjacent to and to the north of Los Angeles Center is Oakland Center. Flights between Oakland Center and Los Angeles Center departing from or arriving at Los Angeles Basin airports must transit the Ventura/Palmdale corridor, one of four primary corridors available for ingress or egress into the Los Angeles Basin area. These corridors are a result of the numerous Special Use Airspaces (SUAs) which exist within and immediately adjacent to Los Angeles Center. The Ventura/Palmdale corridor is one of the busiest in the world and requires special flow management to maintain maximum capacity usage during peak traffic periods.

The Los Angeles Airspace Capacity Project consisted of three major simulation analysis tasks. They are: (1) Los Angeles International Airport capacity analysis; (2) Los Angeles Center airspace choke point delay analysis; and (3) Los Angeles Basin airspace realignment analysis. Results of each were analyzed with respect to increasing capacity, reducing delay, and improving the overall efficiency of air traffic operations and are summarized below.

4.7.1 Los Angeles International Airport Capacity Analysis

The objective of this task was to determine the arrival and departure capacity of Los Angeles International Airport under various operating conditions and the sensitivity of the airport capacity to variations in key operational parameters.

10. Los Angeles Airspace Capacity Project (December 1988)
11. Los Angeles International Airport, Airport Capacity Enhancement Plan (September 1992)

Simulation results show that under baseline operating conditions, the maximum arrival/departure capacity of Los Angeles International Airport was 138 operations per hour during IFR conditions and 166 operations per hour under VFR conditions. However, high levels of delay would occur if the airport were operated at capacity. For baseline operating conditions, the level of operations under which delays remain small are approximately 116 operations per hour under IFR conditions and 140 operations per hour under VFR conditions.

The goal of the Capacity Design Team at Los Angeles International Airport was to develop an action plan of alternatives to increase airport capacity, improve airport efficiency, and reduce aircraft delays. These must coincide with improvements mentioned above if maximum capacity is to be realized. Those recommendations that directly relate to airport capacity at the airport can be found in Appendix C.

Recommendations for Los Angeles International Airport designed for airfield improvements included: constructing departure pads (staging areas) at ends of runways, extending taxiways, constructing high-speed taxiways, and extending Runway 24R. Facility and equipment improvements recommended included upgrading the ILS on Runway 25L to CAT III.

4.7.2 Airspace Choke Point Delay Analysis

The flow of traffic in the Los Angeles Basin is affected by large areas of Special Use Airspace. There are four major choke points through which traffic to and from the Los Angeles Basin must pass due to Special Use Airspace.

The fact that these choke points cause delay for flights transiting these corridors has been observed by the FAA for some time. Speed reductions, path stretching, and other controller techniques initiated during peak traffic demand periods provide evidence that delay does occur.

Simulation results show that substantial delays are incurred by traffic passing through choke points in Los Angeles ARTCC airspace. Modest increases in traffic volume will result in substantial increases in delay unless choke point constraints are released to increase capacity.

4.7.3 Los Angeles Basin Airspace Realignment Analysis

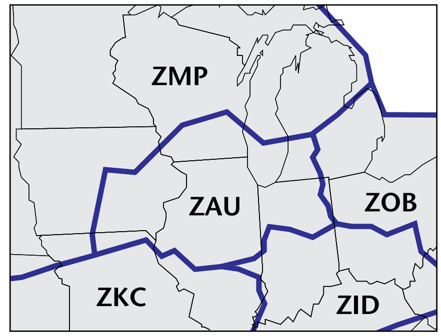
A saturation problem exists in the Los Angeles Center which constrains the capacity of the airspace structure. It is primarily due to the complexity and intensity of operations in Sector 21 of the Los Angeles Center. Sector 21 is a relatively small sector encompassing, at its maximum, a distance of approximately 35 miles from north to south and 50 miles from east to west. The bottom of Sector 21 airspace commences at an altitude of 7,000 feet and reaches its highest altitude at FL230.

The workload complexity factors associated with Sector 21 traffic flow are as a result of the fact that (1) the majority of traffic tends to converge to one point within Sector 21; (2) the closure rate between aircraft is significantly high, especially in head-on situations; (3) lower performance aircraft must be interleaved with the higher performance jet traffic, which complicates operations; and (4) within the limited airspace available, traffic flows must be merged to satisfy minimum separation standards required under the en route airspace environment.

Potential airspace and routing changes for Sectors 21 and 22, and Los Angeles and Coast TRACONs were defined. Major modifications to the old system included expanding the lateral boundaries of Coast TRACONs, establishing a common ceiling of 13,000 feet for Coast and Los Angeles TRACONs, and rerouting departures from Los Angeles International, Orange County, and Long Beach Airports to the Coast TRACON.

Simulation results show that realignment of the Los Angeles Basin airspace will relieve the airspace saturation in Los Angeles ARTCC Sector 21 and result in substantial improvements in efficiency. Airspace capacity will be substantially increased in the new airspace realignment enabling increased volumes of traffic to be handled with less delay. For the near-term traffic demand, delay will be five times greater under the existing airspace structure than with the new realigned airspace and at a level of 40 percent increase in traffic (the nominal forecast projection), the delay is nine times greater under the old system than the new system. The airspace realignment will increase traffic loading for both Los Angeles and Coast TRACONs. This increased traffic can be accommodated without increased delay, assuming that sufficient controller staffing is available to provide adequate sectorization of the terminal airspace.

4.8 Chicago Airspace Project[12,13]



The purpose of the Chicago Airport/Airspace Capacity Project was to support the planning efforts of the FAA's Great Lakes Region in evaluating alternatives addressing capacity and delay problems in the greater Chicago metropolitan area. Potential solutions involved operational alternatives that included airspace realignment, route redesign, new runways, and revised procedures to enhance the efficiency and safety of air traffic operations. The operations of primary concern were en route and terminal airspace operations in the Chicago Air Route Traffic Control Center (ARTCC), terminal airspace operations in the Chicago Terminal Radar Approach Control (TRACON), and airfield operations at Chicago O'Hare (ORD) and Midway (MDW) Airports.

The Chicago TRACON provides air traffic control services in the terminal airspace encompassing O'Hare Airport and several other satellite airfields. In addition to O'Hare Airport, the primary airport, there are 23 satellite airports controlled by the different control positions within Chicago TRACON.

The simulation analysis involved various scenarios using the existing airfield facilities, proposed airfield improvements at O'Hare Airport, and the existing and proposed airspace systems. Various weather conditions and traffic demand levels were simulated to provide an adequate assessment of the relative benefits or drawbacks of the various airfield/airspace options. The runway options and alternatives for O'Hare Airport that were simulated included existing runways and the potential options of adding one or two new air carrier runway(s), including changes in operational procedures and realignment of Chicago Center airspace.

4.8.1 Baseline Operations

The existing airfield of Chicago's O'Hare International Airport consists of three sets of parallel runways: a pair of northeast/southwest runways, a pair of southeast/northwest runways, and a pair of east/west runways. In addition, a smaller general aviation commuter north/south runway is located north of the terminal area, but is used only sparingly.

12. Chicago Airport/Airspace Capacity Project (June 1990)
13. Chicago Delay Task Force: Delay Reduction/Efficiency Enhancement Final Report (April 1991)

The existing airspace system utilizes a four "cornerpost" design for arriving aircraft bound for airports within the Chicago TRACON. The en route system uses a network of airways to merge O'Hare Airport traffic entering the terminal area over the four cornerposts. Aircraft depart the Chicago TRACON airspace in the existing airspace system initially on the four cardinal directions, i.e., north, south, east, and west. Traffic departing satellite airports, with a few exceptions, are provided in-trail spacing with O'Hare departures proceeding over a common fix.

Simulation results of baseline operations show that the predominantly east and west direction of flow of inbound flights to O'Hare Airport, along with the present location of the four cornerposts, results in uneven loading of two cornerposts during peak arrival periods. These traffic flow imbalances at the arrival fixes result in delay as inbound traffic is constrained during these uneven loading situations.

O'Hare Airport arrival traffic on the baseline day was not allowed to free flow through the four cornerposts, that is, special miles-in-trail (MIT) separation restrictions between successive arrivals over a cornerpost were used. Output results revealed that the imposition of MIT restrictions on arrivals over the cornerposts will result in delay increases.

Additional runs were made to evaluate delay impacts of future traffic demand projections, for the short term and the long term, using the baseline airport/airspace system. Simulation results indicate that capacity of the baseline airport/airspace system is not sufficient to accommodate anticipated traffic growth at O'Hare and Midway Airports, thus resulting in substantial delay penalties.

4.8.2 Short-Term Operational Alternatives

The specific alternatives evaluated involved a set of short term airspace realignment and procedural changes that could be implemented over several months. These changes, which were aimed at reducing traffic complexity and workload in the Chicago area airspace to enhance safety, while maintaining the efficiency of operations, included:

(1) rotating the four arrival cornerposts by 45 degrees to the four cardinal directions: north, south, east, and west,

(2) raising the ceiling of the TRACON airspace,

(3) removing holding patterns from the TRACON airspace to provide a dedicated departure corridor for Midway Airport,

(4) establishing merge points for arrivals farther from the TRACON boundary,

(5) eliminating the WHETT departure fix to allow a dedicated departure corridor for Midway traffic, and

(6) establishing a dedicated departure corridor for Midway traffic.

Simulation results show that substantial delay and cost savings would be realized using the short term airspace realignment and procedural changes (without MIT restrictions) described above.

4.8.3 Long-Term Operational Alternatives

The long term options, aimed at increasing capacity and reducing delays in the Chicago area, included building one or two new runways at O'Hare Airport and/or rotating the four arrival cornerposts by 45 degrees to the cardinal directions (as analyzed in the short term alternatives). The benefits of the new runways include capacity gains due to utilizing triple independent approaches in both VFR and IFR. The rotation of the O'Hare TRACON arrival cornerposts increases the number of south satellite arrival fixes by 50 percent (three versus two), allows departures to the south to operate independent of O'Hare Airport traffic, and provides added vectoring-sequencing airspace within the O'Hare TRACON. High performance jet traffic destined to Midway Airport, approaching from a northerly direction would be able to remain at higher altitudes longer, resulting in an operating cost savings for those Midway Airport arrivals.

Simulation results show that delay savings are realized by utilizing the proposed cornerpost rotation and are a result of additional aircraft flowing through arrival fixes and taking advantage of previously unused runway capacity at O'Hare Airport. Delay savings are realized only during VFR operations, because, during operations under IFR, the runway capacity available at O'Hare Airport is not sufficient to take advantage of the airspace capacity gains afforded by the rotated cornerposts. Thus, runway capacity at O'Hare must be increased if the potential benefits of the new airspace capacity are to be realized during IFR conditions.

The addition of two new runways at O'Hare Airport, while utilizing the existing airspace system, provides a reduction in operational complexity, yielding potential safety enhancements, large gains in airport capacity when operating under IFR, and equalized airport capacity during VFR and IFR operations.

Rotation of the arrival cornerposts and addition of two new runways at O'Hare Airport result in substantial delay savings under both VFR and IFR operations. Under VFR, the capacity increases afforded by the new rotated airspace allow full utilization of the new runway capacity. Under IFR, the new airspace provides added flexibility for balancing the use of the new runways, thus yielding greater delay savings than with the existing airspace system.

Additional simulation runs involved assessing the impact of adding only one new runway at O'Hare Airport, while still maintaining the existing four cornerpost system and the case where the arrival fixes are rotated 45 degrees and one new runway is added at O'Hare Airport.

The Final Report of the Chicago Delay Task Force identifies constraints which currently exist in the Chicago airport and airspace operating environment and defines options to explore further which will alleviate these constraints, thereby reducing delays at Chicago's airports. The Chicago Delay Task Force's recommendations are outlined in Appendix C.

The Chicago Delay Task Force issued its final report in April 1991. Since that time, the FAA Great Lakes Region and the City of Chicago have organized the Chicago/FAA Delay Task Force Implementation Team. That team consists of the Airport Technical Working Group and the ATC Technical Working Group.

The Airport Technical Working Group was developed to facilitate implementation of Delay Task Force airport improvement recommendations. The projects selected for the near term are: flow-through aircraft hold pads, Runway 4R angled exit taxiway, and northward relocation of Runways 9L/27R and 4L/22R.

The ATC Technical Working Group was formed to facilitate implementation of Delay Task Force airspace recommendations. The projects currently being analyzed include restructuring of the Chicago airspace and additional CAT II/III approach capability.

4.9 Studies in Progress

Currently, the FAA Office of System Capacity and Requirements has four airspace projects underway: analysis projects in the New York and Jacksonville Centers, the Los Angeles Regulatory Airspace Simplification Project, and a Chicago MLS study.

The New York area airspace analysis is the most ambitious project undertaken to date. It will require an extensive analysis of portions of the New York, Washington, Boston, and Cleveland Centers. It calls for the integration of ARTS and SAR data from 18 approach controls and 86 en route sectors. It will extend from Boston to Richmond and will analyze problems in the New York arrival and departure flows and the integration of Stewart International Airport into the New York airspace complex.

The Jacksonville Center analysis will analyze flow restrictions in Florida airspace created by delegations of Special Use Airspace in the northern Florida and southern Georgia area. It will extend into Washington Center far enough to join with the southern extreme of the New York airspace analysis database. It will also connect with a data base created for an analysis project of the Atlanta Center currently under negotiation. These combined projects will provide the three-Center build necessary to address Congressional concerns with Charlotte and Raleigh-Durham airspace.

The Los Angeles regulatory airspace simplification project does not, as currently envisioned, involve the use of SIMMOD. It will be a three-dimensional depiction of the regulatory and control airspace with the underlying geography and the actual radar track data interfaced. The objective is to determine whether there is regulated airspace that is not used by a significant number of IFR aircraft. If so, that airspace could then be released to allow less restricted VFR flights through the Los Angeles area. This project is being coordinated through the Western Pacific Region with the Southern California Airspace Users Group (SCAG). Any follow-on modeling analysis required will also be accommodated.

The Chicago MLS analysis is an application of a database from an earlier airspace study. The MLS Program Office requested a quantification of the effects of the installation of an MLS at Midway Airport in order to validate the savings benefits computed by their studies at NASA Ames Research Center. It will also study the inter-airport effect of MLS procedures in the Chicago area.